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Specific Activities of Natural Radionuclides and Annual Effective Dose Due to the Intake of Some Types of Children Powdered Milk Available in Baghdad Markets

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Abstract:

In this research the specific activity of natural radionuclides ^{226}Ra, ^{232}Th and ^{40}K were determined by sodium iodide enhanced by thallium NaI(TI) detector and assessed the annual effective dose in Dielac 1 and 2 and Nactalia 1 and 2 for children of less than 1 year which are available in Baghdad markets. The specific activity of ^{40}K has the greater value in all the types which is in the range of allowed levels globally that suggested by UNSCEAR. The mean value of annual effective doses were 2.92, 4.005 and 1.6325 mSv/y for ^{226}Ra, ^{232}Th and ^{40}K respectively.

Key words: Natural Radionuclides, Powdered milk, Contamination, Ingestion, Annual effective Dose.

Introduction:

Uranium – 238, Thorium - 232 series and potassium - 40 represent the natural radioactivity, which is available in the earth's crust and atmosphere. You can reduce the effects of natural radioactivity on the lives of humans and animals through the improvement of water sources, forests and increasing the agricultural areas. Radiation is transmitted to the human body in different ways. Inhalation, including ingestion produced internal dose, is concentrated within the body [1].

Deposited radionuclides are found in the soil to the leaves of plants or absorbed by plant roots and thus enter the food chain to humans and animals [2]. Human activities, accidents, nuclear explosions and industrial activities, the disposal of radioactive waste and sewage sludge lead to soil contamination with radioactive materials [3]. Land contaminated by the presence of natural radioactive materials as a result of origin on the surface is used for agriculture or by extracting and treating of materials with a high content of natural radioactive isotopes (NORM) from within [4]. The concentration of radioactive materials in the tissue can be increased through the ingestion of food or eating that contains radioactive materials, for example, to eat animals to weed or contaminated feed [5]. The factors that control the uptake of radionuclides by the animal is the type

of animal and its mass, age, rate of growth and the way to his eating as it is possible to take radioactive material directly from the soil, especially those that are difficult to be absorbed by plants or feed [6]. Thus, contaminated meat and other animal products as a result of other grazing animals to these plants and contaminated herbs, also pollution can be caused by drinking water that contains natural radioactive materials, which is an important pathway for contamination [7]. People who eat contaminated animal product are exposed to radionuclide internally. The average values of radioactive concentration in soil for ^{238}U, ^{232}Th and ^{40}K were 35, 30 and 400 Bq/kg respectively [8]. The aim of the present work is to determine the specific activity for ^{238}U, ^{232}Th and ^{40}K in different powdered milk samples up taken by children less than 1 year and assessed the annual effective dose which are caused by drinks of these samples.

Materials and Experimental:

The specific activity S.P was calculated by equation [9]:

S.P= A/M … (1)

Where A: The activity that is determined directly from the screen of the system and

M: The mass of sample.

Samples: Dielac 1 and 2 and Nactalia 1 and 2 for children available in Baghdad markets are prepared in 1kg for each sample (one sample for any type of powdered milk). Gamma spectroscopy with Sodium iodide (NaI(TI)) (3" X 3") detector which are calibrated for a period of 3600 seconds, and completely isolated by lead shield [10] were used to determine NORM concentrations, in milk powdered samples.

The specific activity of radioactive series of uranium - 238 and thorium - 232 account has been in directed by identifying the radioactivity for their daughters. Because the NaI(TI) detector is characterized by a poor of his efficiency in energy resolution, it was selected radionuclides daughter to determine the concentration of radioactivity for two series of ^{238}U and ^{232}Th as it was chosen nuclide ^{226}Ra to indicate the radioactivity for a series of ^{238}U , which have been determined through radioactive isotope ^{214}Pb , as well as determined a series of ^{232}Th through a radioactive isotope ^{212}Pb. ^{40}K can be detected clearly and directly by the detector [10]. One kg of the sample in the measuring cylinder is placed inside measurement system that is already calibrated for 3600 seconds [10]. Measurement system has been isolated by the shield from lead to reduce background radiation. Activity was determined directly from the system.

Radiation weighting factor

The radiation weighting factor is a dimensionless factor used to obtain the equivalent dose from the absorbed dose averaged over a tissue or organ and is based on the type of radiation absorbed. The radiation weighting factor for photons equal to 1 [11].

Tissue weighting factor w_T

For the purpose of radiation protection, it was calculated or determined the sensitivities of different organs or tissues stochastic effects of radiation and then multiply the sensitivities by the equivalent dose to calculate the amount equivalent dose received by those organs or tissues. The tissue weighting factors for lungs, gonads, thyroid and brain are 0.12, 0.08, 0.04 and 0.01 respectively [11].

Annual Effective Dose

The annual effective dose (AED in Sv/y) to the public can be given according to ICRP [12];

$$AED(Sv.y^{-1}) = C(Sv.Bq^{-1})\ X\ A_i(Bq.y^{-1}) \quad \dots(2)$$

C is the coefficient of dose conversion for ingestion ($Sv{\cdot}Bq^{-1}$). The annual intake (A_i in Bq/y) from taking milk for a children at age less than 1 year consuming 200 gm/day is considered by equation [11];

$$A_i(Bq.y^{-1}) = S.A(Bq.kg^{-1}) \times 365 \times consumption\ of\ milk \ldots.(3)$$

For children at age less than 1 year, the coefficient of dose conversion C for ^{226}Ra, ^{232}Th and ^{40}K were recommended 4.7 x 10^{-6}, 4.6 × 10^{-6} $Sv{\cdot}Bq^{-1}$ and 6.2 × 10^{-8} respectively [11]. The annual effective doses due to the intake were calculated by using equation 1.

Results and Discussion:

Specific activity of the three radionuclides in the different samples are listed in Table 1.

Table 1: The specific activity of the three radionuclides in the different samples of milk.

Sample	Ra - 226 Bq.kg^{-1}	Th - 232 Bq.kg^{-1}	K - 40 Bq.kg^{-1}
Dielac1	7.56	22.54	458.95
Dielac2	6.67	7.81	527.05
Nactalia 1	6.75	2.74	378.4
Nactalia 2	13.06	14.61	77.67
Averag e	8.51	11.925	360.5175

The maximum average value of specific activity appeared in ^{40}K. The maximum value of specific activity for ^{226}Ra appeared in Nactalia2, the minimum value in Dielac2, with the average of 8.51 Bq/kg. The average value of specific activity for ^{232}Th was 11.925 Bq/kg. The maximum value was found in Dielac1 and the minimum value was in Nactalia1, and the average value of specific activity for ^{40}K were 360.5175 Bq/kg, the maximum and minimum values of specific activity were found in Dielac2, Nactalia2 respectively. The sharing of specific activity for ^{226}Ra, ^{232}Th and ^{40}K in powdered milk was illustrated in Figures 1, 2 and 3.

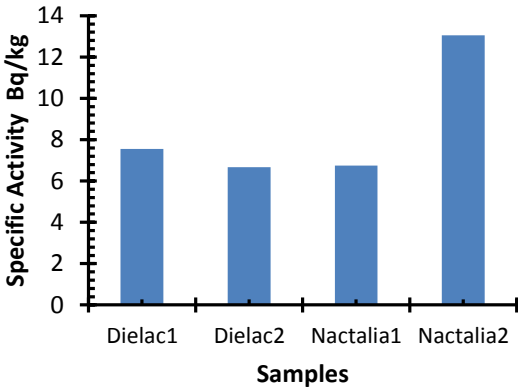

Fig. 1: ^{226}Ra Specific activity (Bq/kg) in powdered milk.

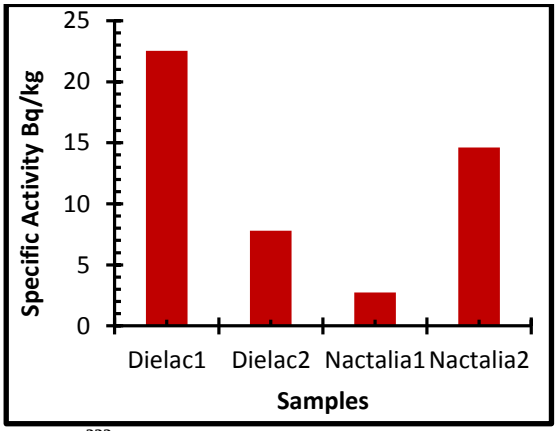

Fig. 2: ^{232}Th Specific activity (Bq/kg) in powdered milk.

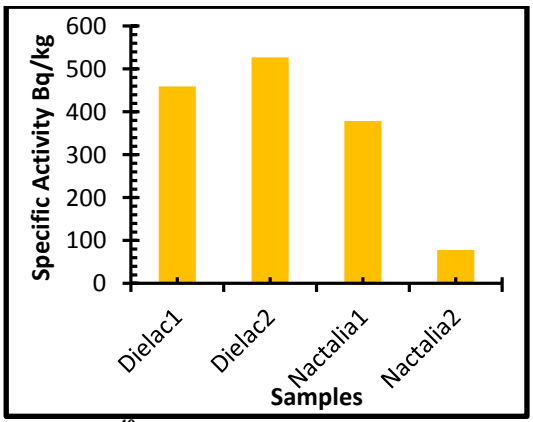

Fig. 3: ^{40}K Specific activity (Bq/kg) in powdered milk.

The annual effective dose *AED*. mSv/y was calculated by equation 1 and listed in Table 2.

Table 2: The annual effective dose of the three radionuclides in different

powdered milk.

Sample	AED. ^{226}Ra (mSv/y)	AED. ^{232}Th (mSv/y)	AED. ^{40}K (mSv/y)
Dielac1	2.59	7.57	2.08
Dielac2	2.29	2.62	2.39
Nactalia1	2.32	0.92	1.71
Nactalia2	4.48	4.91	0.35
Average	2.92	4.005	1.6325

From Table 2, one can notice that the average value of AED. that were accumulated from ^{226}Ra in powdered milk samples was 2.92 mSv/y. The highest value was 4.48 mSv/y in Naclalia2 sample while the lowest value was 2.32 mSv/y. The average, the highest and lowest values of AED from ^{232}Th were 4.005, 7.57 and 0.92 mSv/y in Dielac1 and Nactalia1 respectively and the average, the highest and lowest values of AED. from ^{40}K were 1.6325, 2.39 and 0.35 mSv/y respectively as shown in Figures 4, 5 and 6.

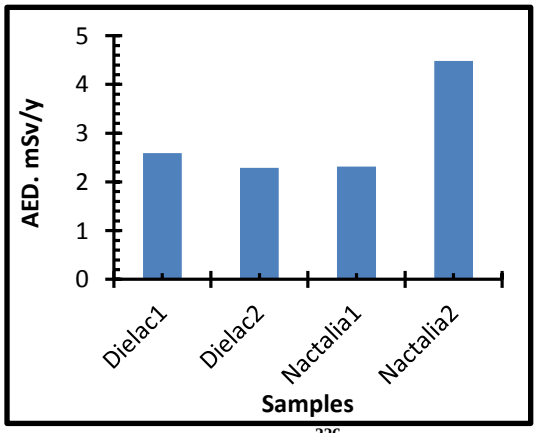

Fig. 4: AED. (mSv/y) for ^{226}Ra in powdered milk.

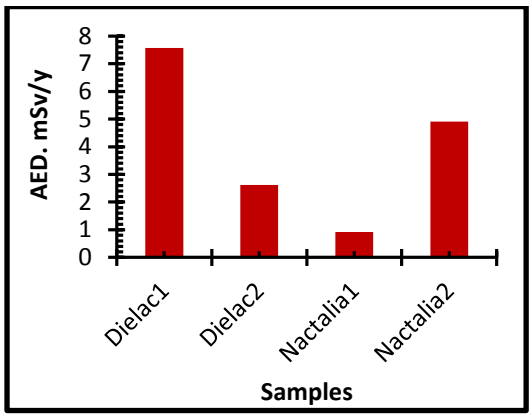

Fig.5: AED. (mSv/y) for ^{232}Th in powdered milk.

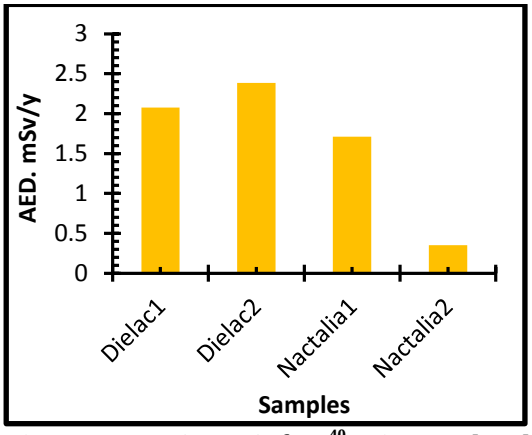

Fig. 6: AED. (mSv/y) for ^{40}K in powdered milk.

The annual effective dose AED. That is accumulated in any organ in human tissue, can be obtained by:

$$AED.\ in\ tissue = AED.\ X\ W_T \quad \ldots(4)$$

W_T: Tissue weighting factor

The annual effective dose of the three radionuclides from different samples of powdered milk that is accumulated in lungs, gonads, thyroid and brain were listed in Tables 3, 4 and 5.

Table 3: The annual effective dose of ^{226}Ra that accumulated in organs from different samples.

Sample	*AED.* ^{226}Ra mSv/y	Lungs mSv/y	Gonads mSv/y	Thyroid mSv/y	Brain mSv/y
Dielac1	2.59	0.3108	0.2072	0.1036	0.0259
Dielac2	2.29	0.2748	0.1832	0.0916	0.0229
Nactalia1	2.32	0.2784	0.1856	0.0928	0.0232
Nactalia2	4.48	0.5376	0.3584	0.1792	0.0448
Average	2.92				

Table 4: The annual effective dose of ^{232}Th that accumulated in organs from different samples.

Sample	*AED.* ^{232}Th mSv/y	Lungs mSv/y	Gonads mSv/y	Thyroid mSv/y	Brain mSv/y
Dielac1	7.57	0.9084	0.6056	0.3028	0.0757
Dielac2	2.62	0.3144	0.2096	0.1048	0.0262
Nactalia1	0.92	0.1104	0.0736	0.0368	0.0091
Nactalia2	4.91	0.5892	0.3928	0.1964	0.0491
Average	4.005				

Table 5: The annual effective dose of ^{40}K that accumulated in organs from different samples.

Sample	*AED* ^{40}K mSv/y	Lungs mSv/y	Gonads mSv/y	Thyroid mSv/y	Brain mSv/y
Dielac1	2.08	0.2496	0.1664	0.0832	0.0208
Dielac2	2.39	0.2868	0.1912	0.0956	0.0239
Nactalia1	1.71	0.2052	0.1368	0.0684	0.0171
Nactalia2	0.35	0.042	0.028	0.014	0.0035
Average	1.6325				

Conclusion:

Specific activity for ^{226}Ra, ^{232}Th and ^{40}K in different samples of powdered milk for children were measured by NaI(TI) detector. The average value of specific activity for radionuclide ^{40}K was the highest in all samples. All the values of specific activity for all radioactive isotopes in all powdered milk samples were in the range of the globally allowed values. Assessed annual effective dose to child through ingestion of radionuclides in the body organ within these samples.

References:

[1] Gaso, M. I.; Segovia, N.; Cervantes, M. L.; Herrera, T. and Perez-Silva, E. 2000. Internal Radiation Dose from ^{137}Cs Due to the Consumption of Mushrooms from the Mexican Temperate Mixed Forest. Radiat. Prot. Dosimetry، 87, 213-216.

[2] Avadhani, D. N.; Mahesh, H. M; Karunakara, N.; Narayana, K.; Somashekarappa, H. M. and Siddappa K. 2001. Dietary Intake of ^{210}Po and ^{210}Pb in the Environment of Goa of South-West Coast of India. Health Phys., 81, 438-445.

[3] Rejah, B. Kh. 2011. Measurement of Background Radioactivity in Sewage Sludge for Baghdad City Treatment Stations, Baghdad Science Journal, 8(2): 439- 443.

[4] Oatway, W. B. and Mobbs, S. F. 2003. Methodology for Estimating the Dose to Members of the Public from the Future Use of Land Previously Contaminated with Radioactivity. National Radiological Protection Board, (NRPB-W36).

[5] Center for Food Safety—Nuclear Event and Food Safety. 2013. The Government of the Hong Kong Special Administrative Region.

[6] Ewers, L.W.; Ham, G. J. and Wilkins, B. T. 2003. Review of the Transfer of Naturally Occurring Radionuclides to Terrestrial Plants and Domestic Animals. National Radiological Protection Board, (NRPB-W49).

[7] International Atomic Energy Agency. 1989. Measurement of Radionuclides in Food and the Environment. A Guidebook, Technical Reports Series No. 295, IAEA, Vienna.

[8] United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2012. UNSCEAR 2006 Report. Annex E. Sources-to-Effects Assessment for Radon in Homes and Workplaces. New York: United Nations.

[9] Lederer, C. M.; Shirley, V. S.; Browne, E.; Dairiki, J. M. and Doebler, R. E.; 1978. Table of Isotopes, 7th Edition, Inc. John Wiley.

[10] Rejah, B. Kh. 2015. Natural Occurring Radioactive Materials (NORM) and Technologically Enhanced NORM (TENORM) Measurements on Oil Field in North Region of Iraq. PhD. Thesis, Baghdad University.

[11] International Basic Safety Standard for Protection against Ionizing Radiation and for the Safety of Radiation Sources. 2011. Safety Series No. 115, International Atomic Energy Agency (IAEA), Vienna.

[12] International Commission on Radiological Protection (ICRP) 2013. Age-Dependent Doses to Members of the Public from Intake of Radionuclides: Part 5 Compilations of Ingestion and Inhalation Dose Coefficients (ICRP Publication 72), Pergamon Press; Oxford.

الفعالية النوعية للعناصر المشعة الطبيعية والجرعة المكافئة السنوية الناجمة عن تناول نماذج من مسحوق حليب الاطفال المتواجد في اسواق بغداد

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الخلاصة:

في هذا البحث تم تحديد الفعالية النوعية للنويدات المشعة الطبيعية الراديوم – 226، الثوريوم – 232 والبوتاسيوم – 40 بأستخدام كاشف ايوديد الصوديوم المطعم بالثاليوم NaI(TI) وحساب الجرعة المكافئة السنوية في نماذج من مسحوق الحليب ديالاك 1و2 ونكتاليا 1و2 التي يستخدمها الاطفال دون سن السنة والمتوافرة في اسواق بغداد. معدل الفعالية الاشعاعية الناتج من البوتاسيوم – 40 هو الأعلى في جميع العينات التي تم دراستها. متوسط الجرعة الفعالة السنوية المحسوب هي 2.92 ، 4.005 و 1.6325 ملي سيفرت / سنة لـ الراديوم – 226، الثوريوم – 232 و البوتاسيوم – 40 على التوالي .

الكلمات المفتاحية: النظائر المشعة الطبيعية، مسحوق الحليب، تلوث، البلع، الجرعة المكافئة السنوية.